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The Role of Higher Twist and Positivity Constraints in Determining Polarized Parton Densities

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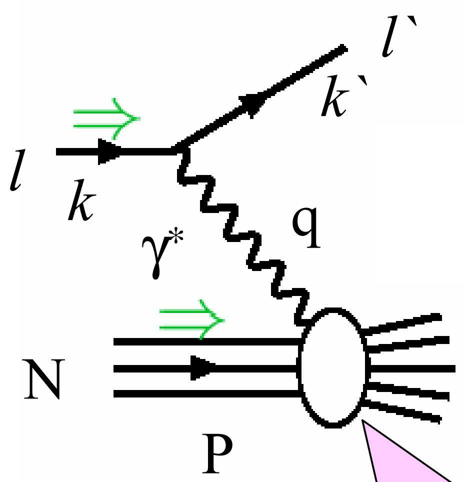
OUTLINE

- **New** QCD fits to the inclusive **polarized** DIS data
  - ⇨ two sets of **polarized** PD (in both the $\overline{\mathrm{MS}}$ and the JET schemes)
  - JLab Hall A neutron data
    very recent COMPASS data on A_1^d ⇦ included in the analysis
- Role of **higher twist** in determining polarized PD
- Factorization scheme dependence of the results
- Impact of **positivity constraints** on polarized PD
- Summary

LSS: hep-ph/0503140

Inclusive DIS ⇒ one of the best tools to study the structure of **nucleon**



$Q^2 = -q^2 = 4EE`\sin^2(\theta/2)$

$x = Q^2/(2M\nu) \qquad \nu = E - E`$

DIS regime ==> $Q^2 \gg M^2, \; \nu \gg M$

$F_i(x, Q^2) \quad g_i(x, Q^2)$ ⇐ pQCD

unpolarized SF

polarized SF

As in the unpolarized case the main goal is:

- to test **QCD**
- to extract from the DIS data the **polarized** PD

$$\Delta q(x,Q^2) = q_+(x,Q^2) - q_-(x,Q^2)$$

$$\Delta \bar{q}(x,Q^2) = \bar{q}_+(x,Q^2) - \bar{q}_-(x,Q^2)$$

$$\Delta G(x,Q^2) = G_+(x,Q^2) - G_-(x,Q^2)$$

where "+" and "-" denote the helicity of the parton, along or opposite to the helicity of the parent nucleon, respectively.

The knowledge of the polarized PD will help us:

- to make predictions for other processes like polarized **hadron-hadron** reactions, etc.

- more generally, to answer the question how the helicity of the nucleon is divided up among its constituents:

$$\mathbf{S_z = 1/2 = 1/2\, \Delta\Sigma(Q^2) + \Delta G\, (Q^2) + L_z\, (Q^2)}$$

$$\Delta\Sigma = \Delta u + \Delta\bar{u} + \Delta d + \Delta\bar{d} + \Delta s + \Delta\bar{s}$$

the parton polarizations Δq_a and ΔG are the first moments

$$\Delta \mathrm{q_a}(\mathrm{Q}^2) = \int_0^1 dx \Delta q_a(x, Q^2) \qquad \Delta \mathrm{G}(\mathrm{Q}^2) = \int_0^1 dx \Delta G(x, Q^2)$$

of the helicity densities: $\Delta u(x,Q^2), \Delta\bar{u}(x,Q^2) \ldots, \Delta G(x,Q^2)$

DIS Cross Section Asymmetries

Measured quantities
$$A_{\parallel} = \frac{d\sigma^{\downarrow\Uparrow} - d\sigma^{\uparrow\Uparrow}}{d\sigma^{\downarrow\Uparrow} + d\sigma^{\uparrow\Uparrow}}, \qquad A_{\perp} = \frac{d\sigma^{\downarrow\Rightarrow} - d\sigma^{\uparrow\Rightarrow}}{d\sigma^{\downarrow\Rightarrow} + d\sigma^{\uparrow\Rightarrow}}$$

$$(A_{\parallel}, A_{\perp}) \Rightarrow (A_1, A_2) \Rightarrow (g_1, g_2)$$

where A_1, A_2 are the virtual photon-nucleon asymmetries.

At present, $A_{\parallel}$ is much better measured than $A_{\perp}$

If $A_{\parallel}$ and $A_{\perp}$ are measured
$$\Rightarrow \quad g_1 / F_1$$

If only $A_{\parallel}$ is measured
$$\Rightarrow \quad \frac{A_{\parallel}^N}{D} \approx (1+\gamma^2)\frac{g_1}{F_1}$$

$$\gamma^2 = 4M_N^2 x^2 / Q^2$$ - kinematic factor

NB. γ cannot be neglected in the SLAC, HERMES and JLab kinematic regions

DATA

188 exp. p.

200 exp. p.

CERN **EMC -** A_1^p **SMC -** $A_1^p,\ A_1^d$ **COMPASS -** A_1^d

DESY **HERMES -** $\dfrac{g_1^p}{F_1^p},\ A_1^n$

SLAC **E142, E154 -** A_1^n **E143, E155 -** $\dfrac{g_1^p}{F_1^p},\ \dfrac{g_1^d}{F_1^d}$

JLab **Hall A -** $\dfrac{g_1^n}{F_1^n}$

The data on A_1 ***are really the experimental values of the quantity***

$$\frac{A_{||}^N}{D} = (1+\gamma^2)\frac{g_1^N}{F_1^N} + (\eta-\gamma)A_2^N$$

$$= A_1^N + \eta A_2^N$$

$\gamma \approx \eta$ and A_2 small

very well approximated with $(1+\gamma^2)\dfrac{g_1^N}{F_1^N}$

even when $\gamma(\eta)$ ***can not be neglected***

- An important difference between the kinematic regions of the unpolarized and ***polarized*** data sets

A lot of the present data are at **moderate** Q^2 and W^2 :

$$Q^2 \approx 1 - 5\, GeV^2,\; 4 < W^2 < 10\, GeV^2$$

preasymptotic region

While in the determination of the PD in the unpolarized case we can cut the low Q^2 and W^2 data in order to eliminate the less known non-perturbative HT effects, it is impossible to perform such a procedure for the present data on the spin-dependent structure functions without loosing too much information.

$O(1/Q^2)$

⇨ **HT corrections** should be **important in polarized DIS !**

Theory

In QCD

$$g_1(x,Q^2) = g_1(x,Q^2)_{LT} + g_1(x,Q^2)_{HT}$$

$$g_1(x,Q^2)_{LT} = g_1(x,Q^2)_{pQCD}$$

$$g_1(x,Q^2)_{HT} = h(x,Q^2)/Q^2 + h^{TMC}(x,Q^2)/Q^2$$

target mass corrections which are calculable *J. Blumlein, A.Tkabladze*

dynamical HT power corrections (τ =3,4)
=> non-perturbative effects (model dependent)

In NLO pQCD

$$g_1(x,Q^2)_{pQCD} = \frac{1}{2}\sum_q^{N_f} e_q^2 [(\Delta q + \Delta\bar{q}) \otimes (1 + \frac{\alpha_s(Q^2)}{2\pi}\delta C_q) + \frac{\alpha_s(Q^2)}{2\pi}\Delta G \otimes \frac{\delta C_G}{N_f}]$$

$\delta C_q, \delta C_G - \mathit{Wilson}$ coefficient functions

polarized PD evolve in Q^2 according to **NLO DGLAP** eqs.

N_f (=3) - a number of flavours

Test of QCD and determination of PPD

$$(\Delta q_i, \Delta \overline{q_i}, \Delta G)(x, Q_0^2; a_k) \xrightarrow[\text{DGLAP eqs.}]{\text{pQCD}} (\Delta q_i, \Delta \overline{q_i}, \Delta G)(x, Q^2; a_k)$$

Input PD

a_k – free par.

$$\Rightarrow \quad g_1(x, Q^2; a_k)_{pQCD}$$

$$\chi^2 = \sum_{i,j} \frac{[g_1(x_i, Q_j^2)_{\exp} - g_1(x_i, Q_j^2; a_k)_{pQCD}]^2}{\Delta g_1(x_i, Q_j^2)_{\exp}^2}$$

$$\Rightarrow \quad a_k \pm \Delta a_k$$

Methods of analysis

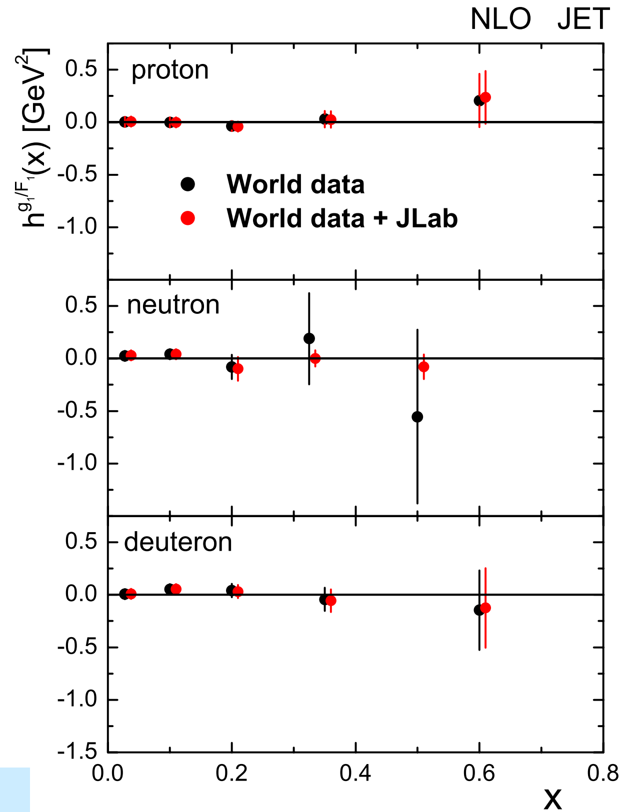
- Fit to g_1/F_1 data - `$g_1/F_1$` fit => PD(g_1/F_1) or Set 1

$$\left[\frac{g_1(x,Q^2)}{F_1(x,Q^2)}\right]_{\exp} \overset{\chi^2}{\Longleftrightarrow} \frac{g_1(x,Q^2)_{LT}}{F_1(x,Q^2)_{LT}} + \frac{h^{g_1/F_1}(x)}{Q^2}$$

$$(g_1)_{QCD} = (g_1)_{LT} + (g_1)_{HT}$$

$$(F_1)_{QCD} = (F_1)_{LT} + (F_1)_{HT}$$

$$\Rightarrow \boxed{h^{g_1/F_1} \approx 0} \Rightarrow \frac{(g_1)_{HT}}{(g_1)_{LT}} \approx \frac{(F_1)_{HT}}{(F_1)_{LT}}$$

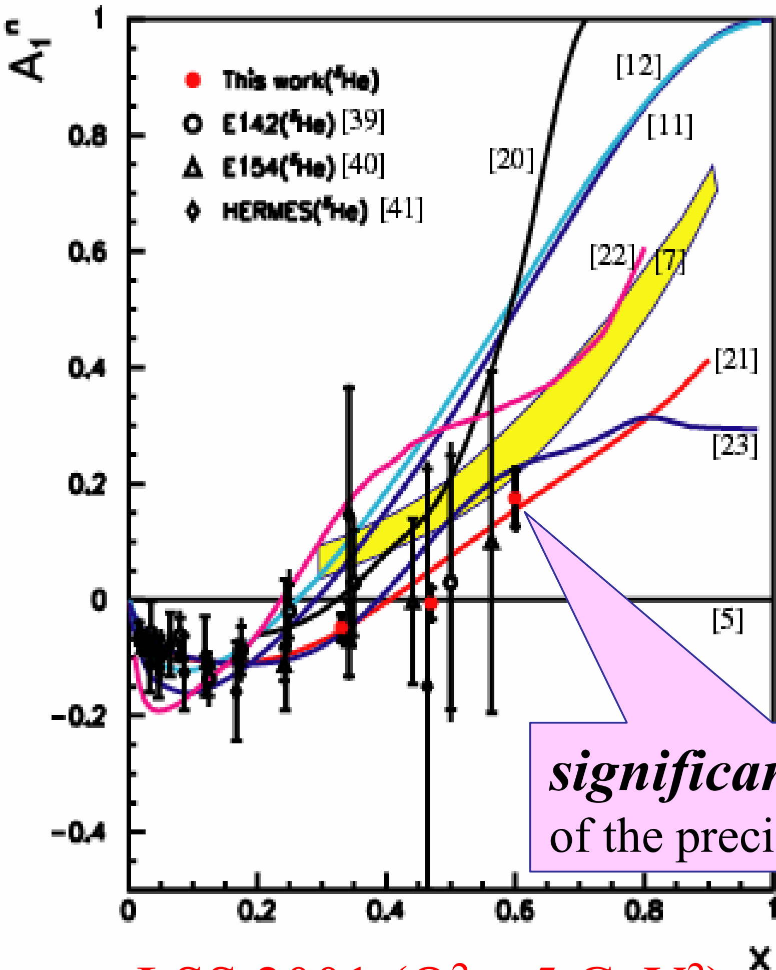


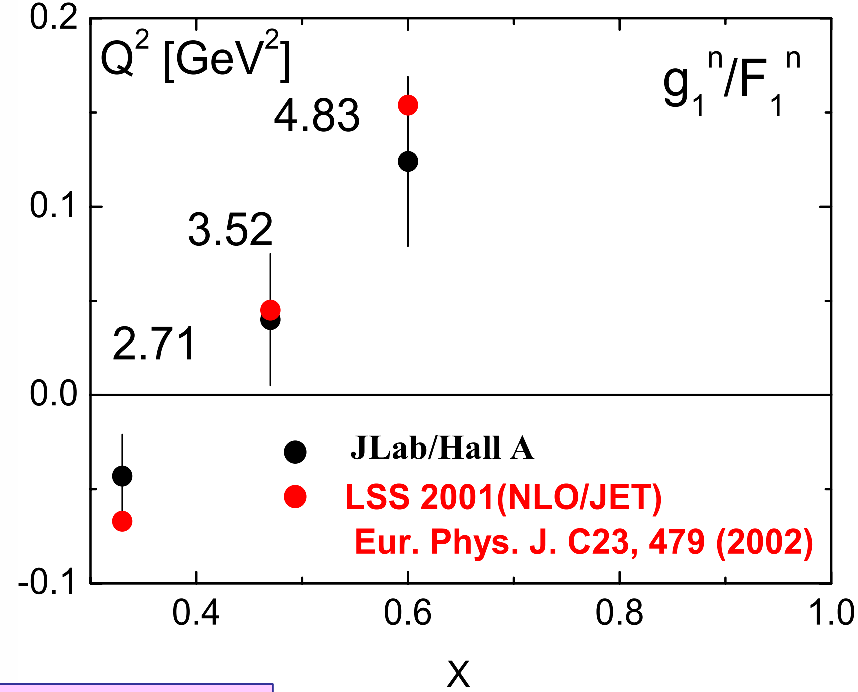
The HT corrections to g_1 and F_1 approximately compensate each other in the ratio g_1/F_1 and the PPD extracted this way are less sensitive to HT effects

LSS: EPJ C23 (2002) 479
hep-ph/0309048

JLab/Hall A: PRL 92 (2004) 012004

Our predictions for the JLAB experimental values of g_1^n/F_1^n using the LSS'2001 NLO(JET) polarized PD





significant improvement of the precision of the data

-LSS 2001 ($Q^2 = 5$ GeV^2)

[21] *Leader,Sidorov,Stamenov, Euro Phys. J. C23, 479 (2002)*

- **Fit to g_1/F_1 data** - *Gluck et al. (GRSV); Leader et al. (LSS)*

$$\left[\frac{g_1(x,Q^2)}{F_1(x,Q^2)}\right]_{\exp} \underset{158.3}{\overset{\chi^2}{\Longleftrightarrow}} \frac{g_1(x,Q^2)_{LT}}{F_1(x,Q^2)_{LT}}; \qquad \chi^2_{dof} = 0.884$$

$$\left[\frac{g_1(x,Q^2)}{F_1(x,Q^2)}\right]_{\exp} \Longleftrightarrow \frac{g_1(x,Q^2)_{LT}}{F_1(x,Q^2)_{LT}} + \frac{h^{g_1/F_1}(x)}{Q^2}$$

$$\Rightarrow \quad h^{g_1/F_1}(x) \approx 0$$

- **Fit to g_1 data** - *SMC; Blumlein, Bottcher (BB); AAC*

$$g_1(x,Q^2)_{\exp} = \left[\frac{g_1(x,Q^2)}{F_1(x,Q^2)}\right]_{\exp} F_1(x,Q^2)_{\exp} \underset{240.7}{\overset{\chi^2}{\Longleftrightarrow}} g_1(x,Q^2)_{LT}$$

from g_1/F_1 fit

$(F_2)_{\exp}$, $R_{\exp}$

$$g_1(x,Q^2)_{\exp} \underset{212.5}{\overset{\chi^2}{\Longleftrightarrow}} g_1(x,Q^2)_{LT}$$

$$g_1(x,Q^2)_{\exp} \underset{149.8}{\overset{\chi^2}{\Longleftrightarrow}} g_1(x,Q^2)_{LT} + h^{g_1}(x)/Q^2; \qquad \chi^2_{dof} = 0.886$$

important

- Fit to g_1 data - `$g_1$+HT` fit => PD(g_1+HT) or Set 2

$$\left[\frac{g_1(x,Q^2)}{F_1(x,Q^2)}\right]_{exp} F_1(x,Q^2)_{exp} = g_1(x,Q^2)_{exp} \overset{\chi^2}{\Longleftrightarrow} g_1(x,Q^2)_{LT} + h^{g_1}(x)/Q^2$$

F_2^{NMC}, R_{1998}(SLAC)

in model independent way

HT corrections to g_1 cannot be compensated because the HT corrections to F_1(F_2 and R) are absorbed in the phenomenological parametrizations of the data on F_2 and R.

Input PD $\Delta f_i(x,Q_0^2) = A_i x^{\alpha_i} f_i^{MRST}(x,Q_0^2)$ $Q_0^2 = 1\,GeV^2,\ A_i, \alpha_i - free\ par.$

$h^p(x_i), h^n(x_i) - 10\ parameters\ (i = 1,2,\ldots 5)$ to be determined from a fit to the data

8-2(SR) = 6 par. associated with PD; positivity bounds imposed by **MRST'02** unpol. PD

$$g_A = (\Delta u + \Delta\bar{u})(Q^2) - (\Delta d + \Delta\bar{d})(Q^2) = \mathrm{F} - \mathrm{D} = 1.2670 \pm 0.0035$$

$$a_8 = (\Delta u + \Delta\bar{u})(Q^2) + (\Delta d + \Delta\bar{d})(Q^2) - 2(\Delta s + \Delta\bar{s})(Q^2) = 3F - D = 0.585 \pm 0.025$$

Flavor symmetric sea convention: $\Delta \mathrm{u}_{sea} = \Delta\bar{\mathrm{u}} = \Delta \mathrm{d}_{sea} = \Delta\bar{\mathrm{d}} = \Delta \mathrm{s} = \Delta\bar{\mathrm{s}}$

SR for n=1 moments of PD

$$g_A = (\Delta u + \Delta\bar{u})(Q^2) - (\Delta d + \Delta\bar{d})(Q^2) \quad = 1.2670 \pm .0035 \qquad (1)$$

$$a_8 = (\Delta u + \Delta\bar{u})(Q^2) + (\Delta d + \Delta\bar{d})(Q^2) - 2(\Delta s + \Delta\bar{s})(Q^2) = 3F - D \quad = 0.585 \pm 0.025 \qquad (2)$$

The sum rule (1) reflects the isospin SU(2) symmetry, whereas the relation (2) is a consequence of the SU(3) flavour symmetry treatment of the hyperon β-decays.

While isospin symmetry is not in doubt, there is some question about the accuracy of assuming $SU(3)_f$ symmetry in analyzing hyperon β-decays. The results of the recent KTeV experiment at Fermilab on the β-decay of Ξ^0, $\Xi^0 \to \Sigma^+ e\bar{\nu}$, however, are all *consistent* with *exact* $SU(3)_f$ symmetry. Taking into account the experimental uncertainties one finds that $SU(3)_f$ breaking is at most of order 20%.

KTeV experiment
Fermilab

$$\Xi^0 \rightarrow \Sigma^+ e \bar{\nu}$$

β-decay

$SU(3)_f$ prediction for the form factor ratio g_1/f_1

$$\frac{g_1}{f_1} = g_A = 1.2670 \pm .0035$$

Experimental result

$$\frac{g_1}{f_1} = 1.32^{+0.21}_{-0.17} \pm 0.05$$

A good agreement with the ***exact*** $SU(3)_f$ symmetry !

From exp. uncertainties ⇒ SU(3) breaking is at most of order **20%**

NA48 exp. at CERN => will improve the stat. error (~ 500 => 6238 events)

RESULTS OF ANALYSIS

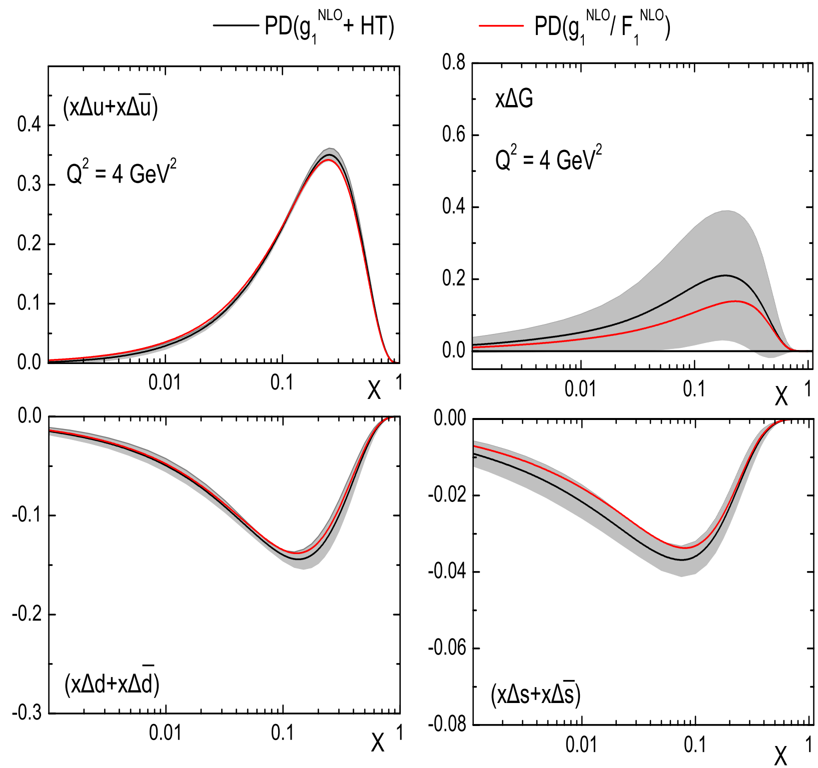
- $(\Delta u + \Delta \bar{u}), (\Delta d + \Delta \bar{d})$ well determined
- $(\Delta s + \Delta \bar{s})$ reasonably well determined and negative if accept for a_8 its SU(3) symmetric value $a_8 = 3F\text{-}D = 0.58$
- ΔG not well constrained

$$PD(g_1^{NLO} + HT) \Leftrightarrow PD(g_1^{NLO} / F_1^{NLO})$$

$$\chi^2_{DF,NLO} = 0.872 \Leftrightarrow \chi^2_{DF,NLO} = 0.874$$

In g_1 data fit HT corrections are important !

NLO($\overline{\text{MS}}$)



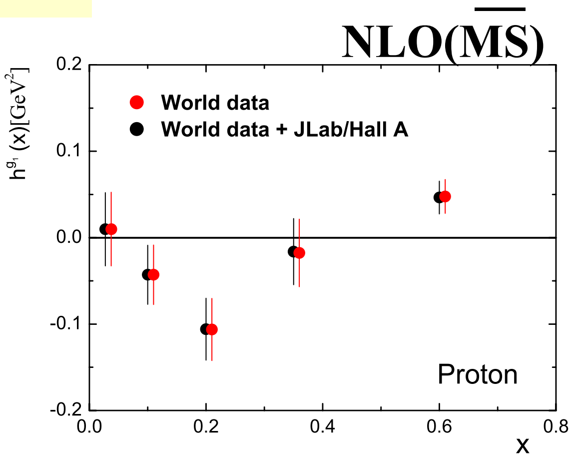
The two sets of polarized PD are very close to each other, especially for u and d quarks.

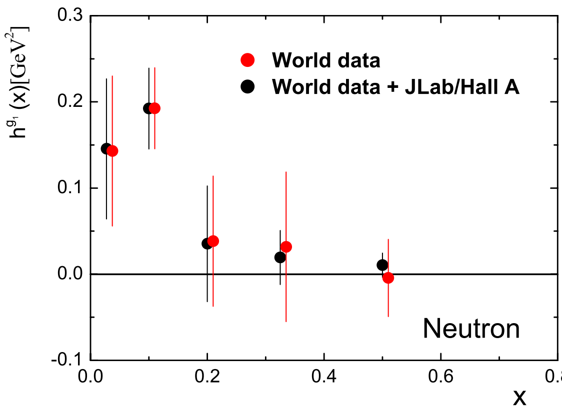
Higher twist effects

- **The size of HT coorections to g_1 is NOT negligible**
- **The shape of HT depends on the target**
- **Thanks to the very precise JLab Hall A data the higher twist corrections for the neutron target are now much better determined at large x.**

$$\int_0^1 dx\, h^{g_1}(x) = \frac{4}{9} M^2 (\underbrace{d_2}_{\text{HT }(\tau=3)} + \underbrace{f_2}_{\text{HT }(\tau=4)})$$

- **Our result is in agreement with the instanton model predictions (*Balla et al., NP B510, 327, 1998*) but disagrees with the renormalon calculations (*Stein, NP 79, 567, 1999*).**





LSS'05 **Osipenko et al.** *Phys. Rev. D71, 054007, 2005*

Main goal

To extract correctly PPD including the data in the preasymptotic region (Q^2: 1 – 5 GeV^2, **$W^2 > 4$ GeV^2**)

Mainly to study the HT effects. The data in the **resonanse** region are also included

The analysis is performed

in Bjorken x-space

in n-space of the Nachtmann moments of g_1

Data set

$g_1(p,n,d)$

g_1^p

LT + HT approximations

$\text{NLO}, \ O(1/Q^2)$

$\text{NLO} \oplus \text{SGR}$ (soft gluon resummation)

$O(1/Q^2) + O(1/Q^4)$

- Not easy to compare directly the results of the two analyses
- Is the quark-hadron duality satisfied in the polarised case?

(A.Fantoni et al., hep-ph/0501180)

Effect of COMPASS A_1^d data (*hep-ph/0501073*) on polarized PD and HT

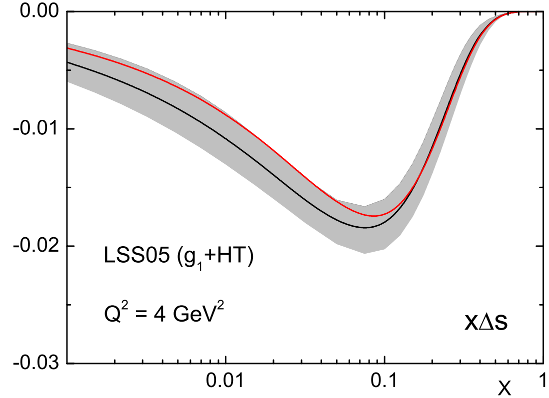
- The statistical accuracy at small x:
  $0.004 < x < 0.03$
  is **considerably** improved

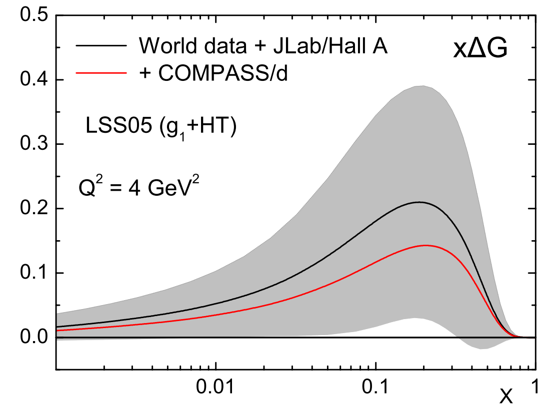
- $\Delta u_v(x)$ and $\Delta d_v(x)$ do **NOT** change in the exp. region

- $x|\Delta s(x)|$ and $x\,\Delta G(x)$ **decrease**, but the corresponding curves lie within the error bands

LSS'05: *hep-ph/0503140*

NLO($\overline{\mathrm{MS}}$)





COMPASS (high p_t hadron pairs with $Q^2 > 1$ GeV^2) – *hep-ex/0501056*

$$\Delta G/G = 0.06 \pm 0.31(\text{stat}) \pm 0.06(\text{sys}) \text{ at } \langle x_G \rangle = 0.13 \pm 0.08$$

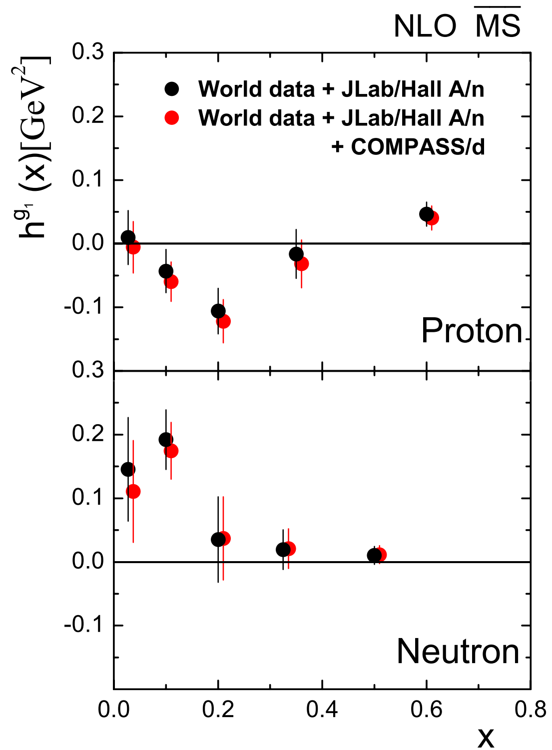
LSS'05 result

$$\Delta G/G = \begin{cases} 0.058 & \text{Set 1/NLO}(\overline{\text{MS}}) \\ 0.095 & \text{Set 2/NLO}(\overline{\text{MS}}) \end{cases} \quad \text{for } x=0.13,\ Q^2=2\ \text{GeV}^2$$

G(x,Q2) is the NLO MRST'02 unpolarized gluon density

Effect of the COMPASS data on the HT values

- The new values are in **good agreement** with the old ones
- The COMPASS data are in the DIS region
  ⇒ their effect on HT is **negligible**

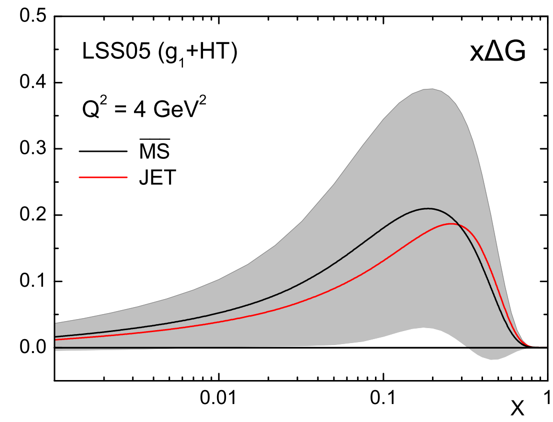


Factorization scheme dependence

NLO polarized PD in $\overline{MS}$ and JET schemes

- In NLO QCD the **valence quarks** and **gluons** should be the **same** in both schemes, while

$$\Delta s(x,Q^2)_{JET} = \Delta s(x,Q^2)_{\overline{MS}} + \frac{\alpha_S}{2\pi}(1-x)\otimes\Delta G(x,Q^2)_{\overline{MS}}$$



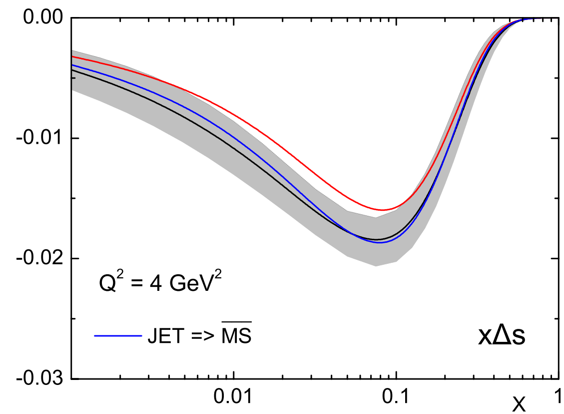
n=1:

$$\Delta\Sigma_{JET} = \Delta\Sigma(Q^2)_{\overline{MS}} + 3\frac{\alpha_S(Q^2)}{2\pi}\Delta G(Q^2)_{\overline{MS}}$$

$\Delta\Sigma_{JET}$ is a **Q^2 independent** quantity

$\Delta\Sigma_{JET}$(DIS) <==> $\Delta\Sigma(Q2\sim\Lambda^2_{QCD})$

CQM, chiral models



Q^2 = 1 GeV^2

Fit	$\Delta\Sigma(Q^2)_{\overline{MS}}$	$\Delta G(Q^2)_{JET}$	$\Delta\Sigma_{JET}$
LSS01	0.21 ± 0.10	0.68 ± 0.32	0.37 ± 0.07
LSS05	0.19 ± 0.06	0.29 ± 0.32	0.29 ± 0.08

Our numerical results for PPD are in a good agreement with pQCD

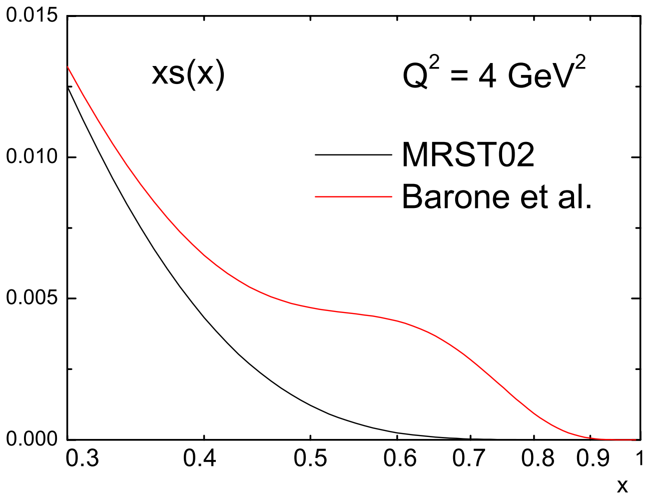
Impact of positivity constraints on polarized PD

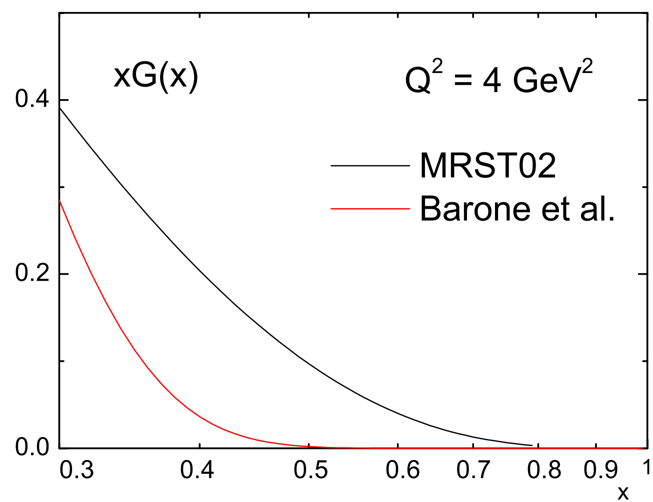
LSS'01 ⟷ LSS'05 (Set 1)

$$|\Delta f(x)| \le f(x)_{\mathrm{Bar.}} \qquad\qquad |\Delta f(x)| \le f(x)_{\mathrm{MRST02}}$$

Bar.: ***Barone et al., EPJ C12 (2000) 243***

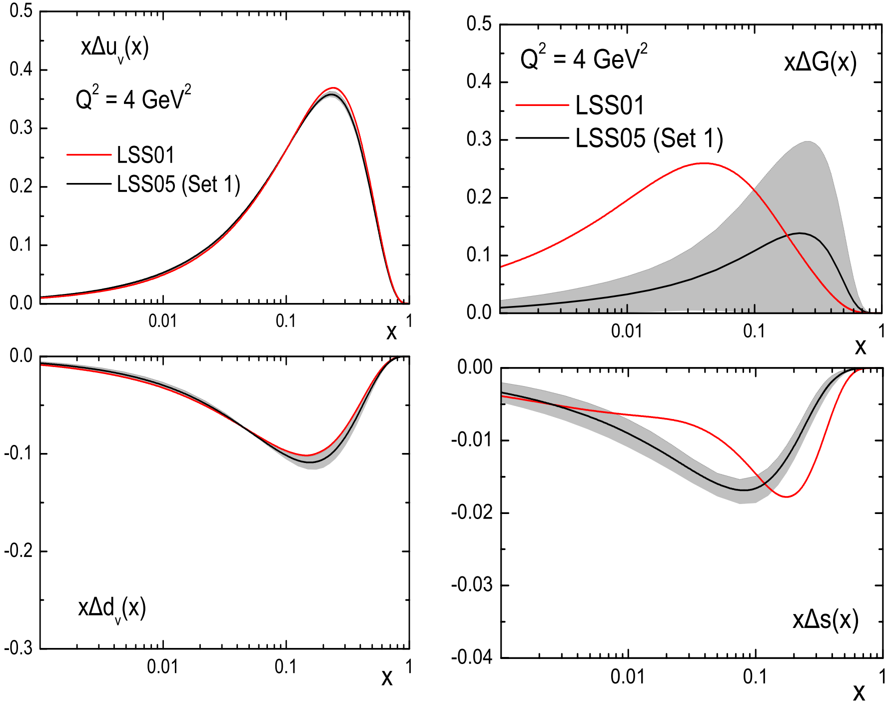
MRST02: ***EPJ C28 (2003) 455***





At large x: $s(x)_{Bar} > s(x)_{MRST02}$ $\qquad G(x)_{Bar} < G(x)_{MRST02}$

$\mathrm{NLO}(\overline{\mathrm{MS}})$



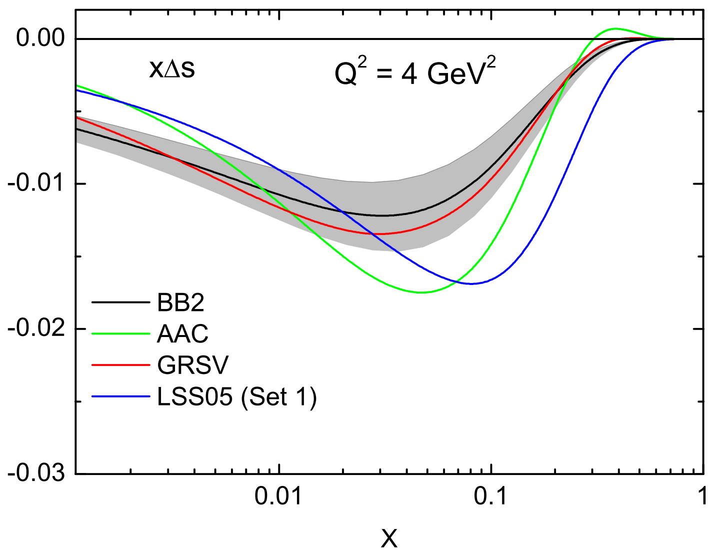
- Δu_v and Δd_v of the two sets are closed to each other
- Δs and ΔG are **significantly** different
- Δs and ΔG are **weakly** constrained from the data, especially for high x. That is why the role of positivity constraints is very **important** for their determination in this region.

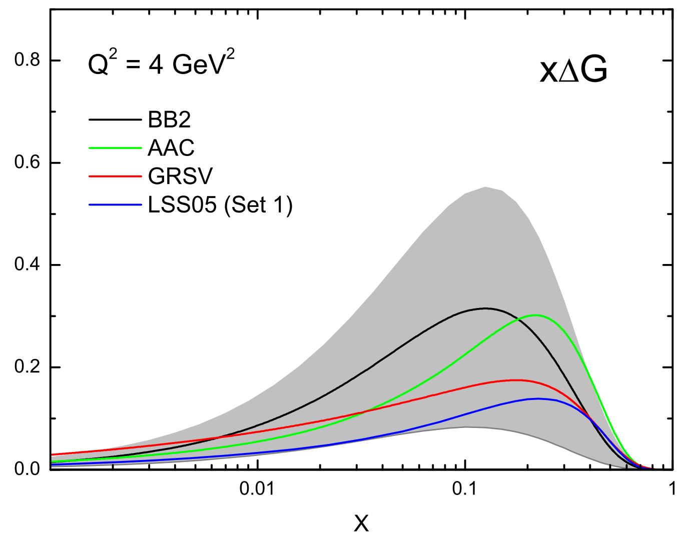
Flavour symmetric sea convention:

$$\Delta u_{sea} = \Delta\bar{u} = \Delta d_{sea} = \Delta\bar{d} = \Delta s = \Delta\bar{s}$$

NLO QCD PPD ($\overline{\text{MS}}$) obtained by different groups

$x\Delta s$ and $x\Delta G$ are **weakly** constrained from the present data on inclisive DIS



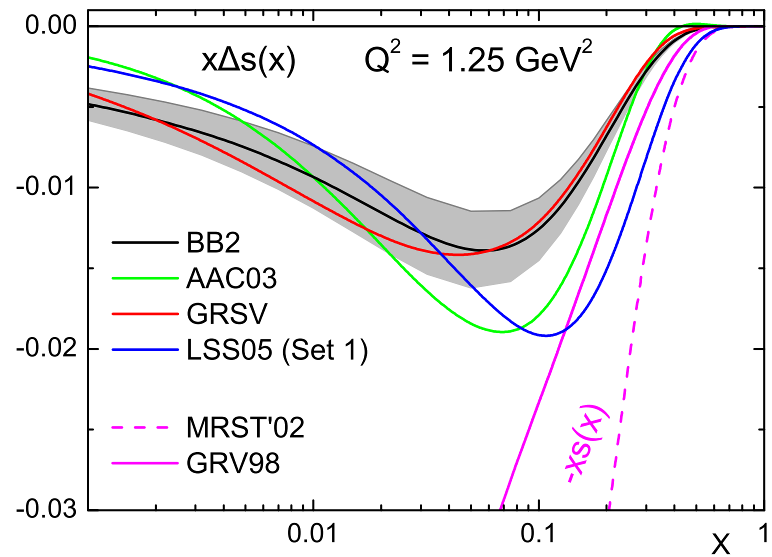


GRSV: Glück et al., hep-ph/0011215
BB: Blümlein, Böttcher, hep-ph/0203155
AAC: Goto et. al., hep-ph/0312112
LSS'05: Leader at al., hep-ph/0503140

$x\Delta u_v$ and $x\Delta d_v$ well consistent

Impact of positivity constraints on $x\Delta s(x, Q^2)$

GRSV: Glück et al., hep-ph/0011215
BB: Blümlein, Böttcher, hep-ph/0203155
AAC: Goto et. al., hep-ph/0312112
LSS'05: Leader at al., hep-ph/0503140



$$| x\Delta f(x, Q_0^2) | \leq xf(x, Q_0^2)_{GRV}$$

$$| x\Delta f(x, Q_0^2) |_{LSS} \leq xf(x, Q_0^2)_{MRST02}$$

GRSV, BB and AAC have used the **GRV unpolarized** PD for constraining their PPD, while LSS have used those of **MRST'02**.

As a result, $x|\Delta s(x)|$ (LSS) for $x > 0.1$ is **larger** than the magnitude of the polarized strange sea densities obtained by the other groups.

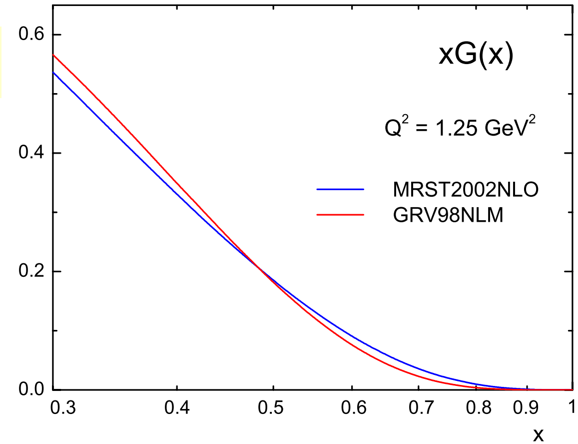
Role of unpolarized PD in determining PPD at large x

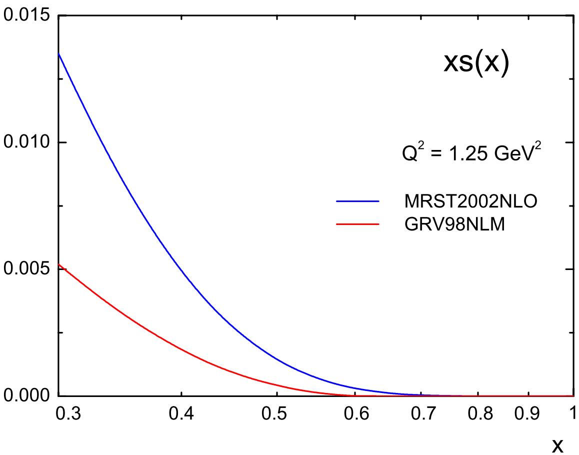
- At large x the unpolarized GRV and MRST'02 **gluons** are practically **the same**, while $xs(x)_{GRV}$ is much smaller than that of MRST'02.

- For the adequate determination of $x\Delta s$ and $x\Delta G$ at large x, the role of the corresponding **unpolarized** PD is very important.

- Usually the sets of unpolarized PD are extracted from the data **in the DIS region** using cuts in Q^2 and W^2 chosen in order to minimize the higher twist effects.

- The latter have to be determined with good accuracy at large x in the **preasymptotic** (Q^2, W^2) region too.



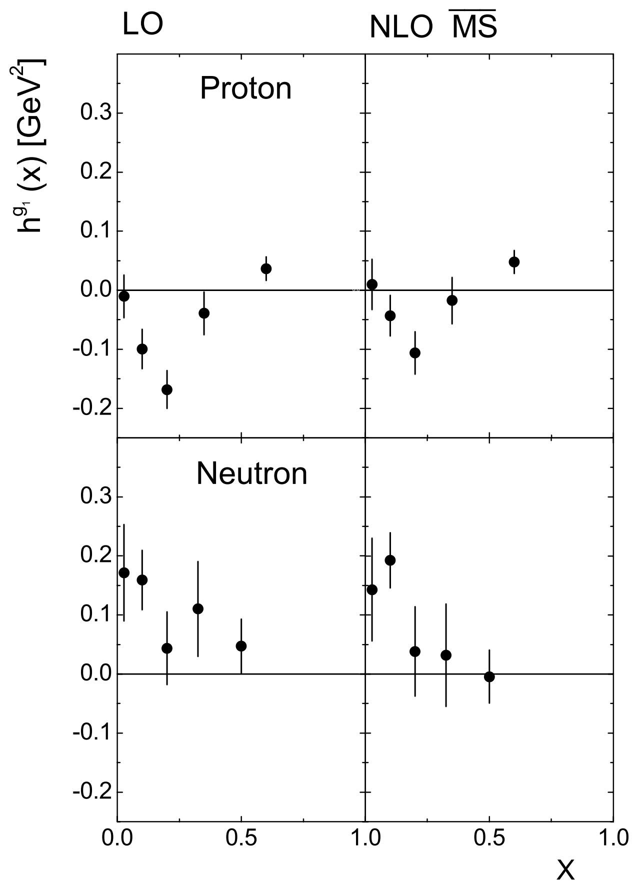


LO QCD approximation - NOT reasonable in the preasymptotic region

- $\alpha_s(Q^2)$ is large
- HT effects are large

Dependence of χ^2 on HT corrections

Fit	LO HT=0	NLO HT=0	LO+HT	NLO+HT
χ^2	249.8	212.5	153.8	149.8
DF	185-8	185-6	185-16	185-16
χ^2 /DF	1.41	1.19	0.910	0.886

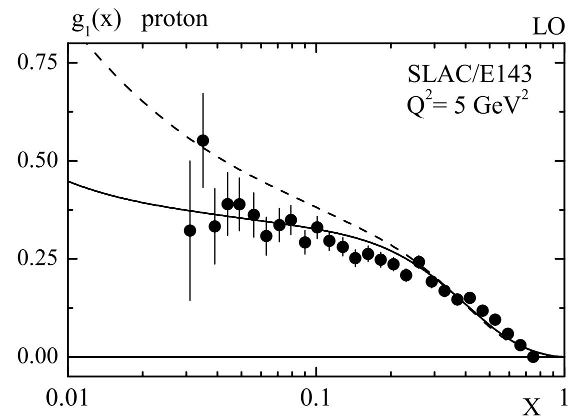


- $$\left[\frac{g_1}{F_1}\right]_{exp} \underset{0.92}{\overset{\chi^2_{DF}}{\Longleftrightarrow}} \frac{g_1^{LO}}{F_1^{LO}}$$

$$\chi^2_{DF}(NLO) = 0.87$$

$$2xF_1^{LO} = F_2^{LO} \Leftarrow (q_a^{LO}, \bar{q}_a^{LO})$$

- at large Q^2 : $2x(F_1)_{exp} \approx (F_2)_{exp}$
- preasymt. region : $2x(F_1)_{exp} < (F_2)_{exp}$ (25-30%)



- - - - g_1/F_1 fit
——— $(g_1 + HT)$ fit

- E04-113, Semi-Sane exp. at JLab Hall C

$$\Delta\bar{u} - \Delta\bar{d} = \frac{1}{2}(\Delta q_3 - \Delta u_V + \Delta d_V)$$

In LO: $\Delta q_3(x,Q^2) = 6 g_1^{(p-n)}(x,Q^2)_{exp}$

In preas. region: $\Delta\tilde{q}_3(x,Q^2) = 6\,[g_1^{(p-n)}(x,Q^2)_{exp} - \dfrac{h^{(p-n)}(x)}{Q^2}]$

$$\text{If } x \in [0.1 - 0.4], \quad Q^2 = 2\,\text{GeV}^2$$

$\Rightarrow$ **HT** contribution is about **24-34%** (LSS'05)

SUMMARY

- Two sets of **polarized** PD in both the $\overline{\mathrm{MS}}$ and the JET schemes are extracted from the world DIS data including the new **JLab** and **COMPASS** data $\Longrightarrow$ in a **good agreement** with the pQCD predictions

- While the HT corrections to g_1 and F_1 **compensate** each other in g_1/F_1, the HT(g_1) are **important** in the analysis of the g_1 data

- Impact of JLab data on PPD and HT $\Longrightarrow$ PPD unchanged, HT for a **neutron** target **much better determined** at high x

- Impact of COMPASS data on PPD $\Longrightarrow$ Δu_v and Δd_v unchanged, $|\Delta s|$ and ΔG **decrease**

- Δs and ΔG are **not** well determined from the data $\Longrightarrow$ the effect of the positivity conditions used to constrain them is **essential**, especially at high x

- A more precise determination of **unpolarized** PD in the **preasymptotic** region is very important